STRUCTURAL PANEL FOR USE IN BUILDINGS

Field

The present invention relates to modular building panels or structural insulated panels utilized to fabricate the walls, ceilings, floors, etc. of houses, room additions, porches, mudrooms, sheds, outbuildings, and the like.

Background

The use of modular building panels is a popular method for economically adding additional enclosed structures to a pre-existing structure. Examples of new structures include room additions and enclosed porches. In many cases these room additional enclosures are used for leisure activities such as reading, watching television, and visiting with guests.

Typically modular building panels cost less than conventional construction materials. Modular building panels may be quickly disposed in an edge to edge configuration to form walls, roofs, etc. The assembly time required to build a structure with modular building panels is typically much less than when building using conventional construction methods. The time and labor savings provides additional cost savings.

Structures built with modular building panels are often exposed to the wind, sun rain, hail, and even seismic activity. It is desirable that structures built with modular building panels be durable enough to withstand exposure to these elements.

It is a popular construction technique to design additions to houses that match the style of the existing structure, both internally and externally. It therefore may be desirable for aesthetic or practical reasons to attach other building construction materials to a modular building panel. For example, it may be desirable to attach conventional shingled roofing material or a drop ceiling to a modular building panel to make the addition look more like an integral part of the building, or to provide additional insulation or protection.

Summary

The description pertains to a structural panel that includes five layers sandwiched together. The two outer layers and the central layer may be made from a harder material such as plywood, aluminum or steel. For example, the two outer layers may be made from aluminum and the inner layer may be made from plywood or other wood. The other two inner layers may be made from a lighter, rigid material, such as expanded polystyrene (EPS) foam or other suitable material. Typically, the structural panel also includes ends on two opposite sides designed to interlock with the ends of other structural panels. These interlocking ends may provide a strong mechanical joint that is resistant to water or is weatherproofed.

The description also pertains to a structural panel that includes seven layers sandwiched together. The two outer layers and the third and fifth layers may be made from a harder material. The other three inner layers (the two layers adjacent the outer layers and the central layer) may be made from a lighter, rigid material such as expanded polystyrene foam. The panel may thus be constructed of alternate layers of a harder material and a lighter, rigid material. The central layer may be made from a honeycomb-type product to provide additional rigidity, sound dampening, or other desired characteristics.

The description also pertains to a structural insulated panel (SIP). These panels are often constructed of a central foam core sheathed with a structural material such as drywall, plywood, or oriented strand board on each side. The other laminate substitutes for the structural material. The laminate may include a rigid foam core sheathed with a thin skin of harder material such as wood, aluminum or steel. The structural insulated panel can be given additional strength by connecting the laminates with ribs of wood, steel or aluminum through the central foam core.

Brief Description of the Drawings

The invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings in which:

Figure 1 is a cross-sectional diagrammatic view of a structural panel;

Figure 2 is a cross-sectional diagrammatic view of another structural panel;

Figure 3 is a cross-sectional diagrammatic view of another structural panel;

Figure 4 is a cross-sectional diagrammatic view of another structural panel;

Figure 5 is a cross-sectional diagrammatic view of another structural panel;

Figure 6 is an isometric diagrammatic view of several structural panels in use; and

Figure 7 is a partial cross-sectional diagrammatic view of a structural panel in use.

Detailed Description

The following detailed description should be read with reference to the drawings, in which like elements in different drawings are numbered identically. The drawings which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the invention.

Figure 1 is a cross-sectional diagrammatic view of a structural panel 100. Structural panel 100 is generally a laminate in structure and includes a membrane 102 disposed between foam layers 104 and 106, with skins 108 and 110 disposed on the outer surfaces of foam layers 104 and 106, respectively. Structural panel 100 may include a male interlocking edge 112 and a female interlocking edge 114, if desired.

Male interlocking edge 112 may be configured to be received and held by the female interlocking edge of another structural panel. This feature may provide rapid weather-tight construction. Of course, the interlocking portions shown in Figure 1 and

other figures are only examples. Other suitable interlocking edges are shown in other figures (for example, Figure 2), and in other art.

Foam layers 104 and 106 are so named for convenience of illustration and are not intended to be limited solely to foam materials. Foam layers 104 and 106 should be made from materials which exhibit good shear strength and stiffness for low density materials. It may also be desirable for these materials to have good compressive loading characteristics. Suitable materials may include foams such as expanded polystyrene (EPS) foam, closed-cell polyvinyl chloride (PVC) foams, polyurethane foams, polymethyl methacrylamide foams, acrylic foams, styrene acrylonitrile foams, expanded polyetherimide/ polyether sulphone foams. Other suitable materials may include honeycomb cores made from cardboard, thermoplastic, nomex, aluminum or other suitable material, metal foams such as aluminum foam, low density woods such as balsa, and gypsum. Foam layers 104 and 106 may be made from the same material or made be made from different materials. Each foam layer may include one, two or more materials, if desired.

Skins 108 and 110 may be made from higher density, higher strength materials whose flexural stiffness is enhanced by joining them with a core material. Suitable materials may include metals such as steel or aluminum, wood products such as plywood, oriented strandboard or fiberboard, or polymers such as polyvinyl chloride (PVC). Of course other materials may be suitable. For example, another suitable material may be vinyl coated aluminum. Each skin may be made from a different material or group of materials. For example, in one embodiment, skin 108 is made from 0.019" or 0.024" aluminum sheet metal and skin 110 is made from plywood.

Membrane 102 may be made from a material selected to increase the flexural stiffness of structural panel 100, and may be selected to increase the fastener retention capability of structural panel 100, as discussed below. Suitable materials may include, for example, those used for skins 108 and 110.

Membrane 102 should be positioned so that a fastener such as a screw or a nail that is driven through one or either of skins 108 or 110 may be at least partially received by the membrane. Thus in one embodiment, membrane 102 may be positioned in the structural panel (during manufacturing) to receive a standard fastener driven through skin 108. In another embodiment, membrane 102 may be positioned to receive a fastener driven through either skin 108 or 110. In a third example embodiment, membrane 102 is positioned to receive a fastener driven only through skin 110.

Skins 108 and 110, foam layers 104 and 106, and membrane 102 may be bonded to each other with adhesive, melt bonding, or other suitable technique.

Figure 2 is a cross-sectional diagrammatic view of a structural panel 200. Structural panel 200 includes skins 108 and 110, foam layers 104 and 106, and membrane 102. Structural panel 200 may also include male interlocking edge 112 and female interlocking edge 114, which are shown to be of a different configuration than those of structural panel 100. Structural panel 200 also includes a second membrane 116 and a third foam layer 118. These layers may be made from the materials described above or any suitable material.

Second membrane 116 may add additional flexural stiffness to structural panel 200 compared with a structural panel 100 of similar thickness and materials. In structural panel 200, member 102 and second member 116 may be spaced apart from skins 108 and

110, respectively, so that a fastener may be adequately secured if driven into structural panel 200 through either skin. Thus structural panel 200 may be thicker than structural panel 100 and still retain fastener retention capabilities on both sides.

Many combinations of materials are contemplated. For example, in one embodiment, skins 108 and 110 are made from vinyl coated aluminum, membranes 102 and 116 are made from plywood, and foam layers 104, 106, and 118 are made from EPS foam. In another example embodiment, Skin 108 is made from epoxy coated steel, skin 110 and membranes 102 and 116 are made from oriented strand board, foam layers 104 and 106 are made from polyurethane foam, and foam layer 118 is made from a paper honycomb. The distance between skin 108 and membrane 102 and the distance between skin 110 and membrane 116 may be, for example, one inch. The distance between membrances 102 and 116 may be, for example, two inches.

Of course, structural panels having more than two membranes and three foam layers are contemplated. For example, one example structural panel has a core including five foam layers separated by four membranes.

Figure 3 is a cross-sectional diagrammatic view of a structural panel 300, which is similar to structural panel 200. Structural panel 300 includes skins 108, and 110, foam layers 104, 106 and 118, and membrane 102 and 116. Structural panel 300 may also include male interlocking edge 112 and female interlocking edge 114. Structural panel 300 also includes a rib 120 extending between membranes 102 and 116. Rib 120 may be made from the same materials as membrane 102 and may be bonded to or integral with the membranes. Rib 120 may also be bonded to foam layer 118. In one example embodiment, structural panel 300 is oblong and rib 120 extends parallel to the longer

dimension of the panel. Another example embodiment is wider than the previous embodiment and the panel includes more than one rib between membranes 102 and 116, extending substantially parallel to each other. In another example embodiment, panel 300 is both wide and long and in addition to rib 120, other ribs extend between membranes 102 and 116, one or more substantially parallel to rib 120 and one or more substantially perpendicular to it or at another angle. Rib 120 along with membranes 102 and 116 create an I-beam configuration, which may provide the structural panel with additional flexural stiffness.

Figure 4 is a cross-sectional diagrammatic view of a structural panel 400. Structural panel 400 has a configuration of a structural insulated panel (SIP) used in certain building techniques that are an alternative to the traditional frame-type construction. Structural panel 400 includes outer layers 402 and 404 separated by and bonded to a foam core 406. Each outer layer is itself a laminate including skins 408 and 410 bonded to a foam layer 412. Foam core 406 may be offset from outer layers 402 and 404 to provide a male edge joint 416 and a female edge joint 414. The materials of skins 408 and 410 may be any of those suitable for skin 108 and the material of foam core 406 or foam layers 412 may be any of those suitable for foam layer 104. In one example embodiment, skins 408 includes 1/4" oriented strand board, skins 410 includes 0.019" steel, foam layers 412 includes 3/4" inch EPS foam, and foam core 406 includes 6" EPS foam. Of course, other materials and dimensions are contemplated. In one example embodiment, foam core 406 includes one or more channels or conduits.

Figure 5 is a cross-sectional diagrammatic view of a structural panel 500. Structural panel 500 includes all the features of structural panel 400 and also includes rib

418 extending between and bonded to layers 402 and 404 to provide additional rigidity. Rib 418 may be made from the any of materials that skins 408 are made from. Embodiments are contemplated in which one or more additional ribs extend between layers 402 and 404.

Figure 6 is an isometric diagrammatic view showing several structural panels 600 in an example use. Structural panels 600 may be any of the previously described structural panels or may be another suitable panel. Structural panels 600 are the roofing structure of a room addition 602 to a house 604. Structural panels 600 are attached to walls 606 and may need no further structural attachment or reinforcement. For example, rafters or ceiling beams in room addition 602 may be unnecessary to support structural panels 600 because of a suitably high flexural strength inherent in the panels. Shingles 608 may be attached to panels 600 using fasteners such as screws or nails, or other suitable means such as adhesive or a combination thereof.

Figure 7 is a partial cross-sectional diagrammatic view of a structural panel 700 with an additional construction member such as a shingle 702 attached with a fastener 704. Structural panel 700 has skins 706, membranes 708, and foam layers 710. Fastener 704 penetrates and is retained by a skin 706 and a membrane 708. Likewise, ceiling panel 712 is attached with fastener 704, which penetrates and is retained by skin 706 and membrane 708. A panel which has only a foam core between two skins may not adequately retain a fastener driven through a skin and into the foam core. The foam core may be too weak to resist a torque acting upon the fastener. The skin therefore must provide adequate resistance to the torque but may be too thin to do so. A panel such as structural panel 700 can better retain a fastener driven through a skin and the membrane.

Much or all of the torque which the skin in the former panel must resist would be resisted as a simple compressive force by membrane 708. Including a membrane may also increase the thickness of material suitable for fastener retention with which a fastener may engage. Of course other construction members can be attached to either side of the panel using fasteners in this manner. For example, drop ceiling supports may be fastened to a roof comprising structural panels, or a wood floor may be nailed to a subfloor comprising structural panels.

Numerous advantages of the invention covered by this document have been set forth in the foregoing description. It will be understood, however, that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, and arrangement of parts or order of steps without exceeding the scope of the invention. The invention's scope is, of course, defined in the language in which the appended claims are expressed.